REMARKS

Applicant thanks the Office for the attention accorded the present Application in the April 4, 2005, Office Action. In that Action, the Office rejected Claims 1-19 under 35 U.S.C. §103(a) as being unpatentable over Black et al. in view of European Patent 182,656 A2 (EP '656).

35 U.S.C. §103(a) rejections

The Office has rejected Claims 1-19 under 35 U.S.C. §103(a) as being unpatentable over Black et al. in view of European Patent 182,656 A2 (EP '656). The Office states that Black discloses a magnetic assembly and a method of making a multistage magnetic rotary seal comprising a shaft having plural ridges, an annular magnet, a first pole piece and a second pole piece. Further, each pole piece has plural ridges along an inner diameter that are spatially opposed to the ridges on the shaft. Additionally, the ridges can be of any shape (col. 10, lines 20-23). The Office also states that Black does not disclose a trapezoidal shape having tapered sides diverging (at an angle between 0 and 180 degrees) from a top plateau to an annular region.

The Office states that EP '656 discloses a magnetic assembly having a shaft, magnet, and two pole pieces and teaches art equivalent shapes for ridges forming stages. Particularly, Figure 8 teaches a trapezoidal shape having tapered, diverging sides from a plateau portion where the sides diverge at an angle between the required range. The Office contends that it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the shape of the ridges to a

trapezoidal shape as such is an art equivalent shape (i.e. to a rectangular shape) as taught by EP '656. Applicant respectfully traverses.

The EP '656 disclosure teaches a ferrofluid rotary exclusion seal apparatus and method of employing a controlled gradient magnetic flux field. Black et al. teaches an on-site refillable ferrofluid seal that can be used on exclusion seals or pressure differential seals. Although Black et al. discloses a multistage seal using rectangular stages, no where in Black et al. is there a recognition that trapezoidal stages provide increased pressure capacity for applications in which a relatively large pressure differential between two environments must be maintained.

EP '656 fails to provide one of ordinary skill in the art the suggestion or motivation to combine the teachings of EP '656 with the teachings of Black et al. to arrive at Applicant's claimed invention. This is so for several reasons, which are supported by the Declaration of Dr. Zhixin Li, Vice-President of Engineering of Ferrotec (USA) Corporation attached hereto.

EP '656 teaches ferrofluid rotary exclusion seals. Exclusion seals and vacuum or high pressure seals are categorically different products based on different principles. Exclusion seals are not designed to sustain a pressure difference on either side of the seal. They are designed to keep contamination out. Further exclusion seals and vacuum or high pressure seals have different performance requirements and are for different applications. According to Dr. Li, exclusion seals have a pressure capacity of about 3 to 5 inches of water while vacuum seals typically have a pressure capacity of higher than 1,000 inches of water. High pressure seals have an even higher pressure

capacity than vacuum seals. This difference requires different knowledge and expertise.

To better understand this difference, Dr. Li provides in his Declaration an interesting example. This difference can be compared to a toddler's tricycle with a speed of 2-3 km per hour to an Indy-500 race care with a speed of 400-500 km per hour, i.e. about 200 times the tricycle. Even though the toddler's tricycle and the Indy-500 race car have wheels, they are based on different technical principles and require different engineering standards. It would be difficult for one of ordinary skill in the art in designing toddler's tricycles to design a high performance Indy-500 race car.

EP'656 discloses an exclusion seal with a single tapered tooth on each side of a magnet. The magnet is typically a rubber magnet. The magnetic field used in exclusion seals is weak. According to Dr. Li, magnetic flux choking caused by the teeth on a pole piece is not a factor. Consequently, the square tooth stage will have the same performance as a tapered tooth stage.

Vacuum seals and high pressure seals are quite different. As disclosed by Dr. Li, the magnetic field in vacuum and high pressure seals is much stronger. Typically, a high energy, rare-earth magnet is used. Unlike the exclusion seals disclosed in EP '656, magnetic flux choking in the teeth area due to the strong magnetic field is a control factor for increasing pressure capacity of the seal. According to Dr. Li, a square tooth will intensify the magnetic flux choking causing a reduction in pressure capacity.

In addition to magnetic flux choking, another phenomenon that affects vacuum and high pressure seals is absent in exclusion seals. According to Dr. Li, this

phenomenon is magnetic field leakage. This phenomenon is another control factor that affects pressure capacity. It is absent in exclusion seals because of the low pressure capacity requirements and the use of a weaker magnetic field. As explained by Dr. Li, understanding this phenomenon as it applies to vacuum seals requires expertise in magnetic theory and the help of a sophisticated analysis tool as well as specialized training to understand and utilize the sophisticated analysis tool.

As disclosed in Applicant's disclosure, a tapered tooth will relieve magnetic flux choking and that, according to Dr. Li's declaration, the use of a double tapered teeth design (i.e., opposing tapered teeth in a multistage seal) also minimizes the magnetic field leakage phenomenon. As previously presented and as the data in Applicant's disclosure indicates, this was unexpected when compared to a double square teeth design and was not within the knowledge possessed by one of ordinary skill in the art of vacuum and high pressure seals regarding the use of square teeth.

It is clear from Dr. Li's declaration, one of ordinary skill in the art of exclusion seals would be unable to use the knowledge gained from EP '656 in combination with that of Black et al. to invent the seal described in the present invention. One of ordinary skill in the art of exclusion seals would not expect that the use of tapered teeth would improve the pressure capacity of the exclusion seal. This is so because, as disclosed by Dr. Li, magnetic choking and magnetic field leakage are not controlling factors to improvements in exclusion seal design since exclusion seals are based on different principles and used for different purposes.

Neither would one of ordinary skill in the art of vacuum/high pressure seals look to exclusion seal art since magnetic flux choking and magnetic field leakage are not phenomena of concern in exclusion seal design. Further, one of ordinary skill in the art of vacuum/high pressure seals knows that magnetic flux choking of square teeth reduces seal capacity. Any design that would increase the focusing of the magnetic field (which is what occurs when using double square teeth) at each tooth would decrease pressure capacity. It is also known by those of ordinary skill in the art that focusing of the magnetic field increases with a decrease in the surface area of the opposed faces of each pair of opposed teeth. However, increasing focusing of the magnetic field also increases magnetic flux choking. Thus, one of ordinary skill in the art would conclude that a tapered tooth design would increase magnetic flux choking leading to decreased seal capacity since a tapered tooth design would have a smaller surface area of the opposed faces of each pair of opposed teeth than that of comparable square teeth causing an increase in the focusing of the magnetic field.

Not only would one of ordinary skill in the art not be motivated to combine Black et al. in view of EP '656, but, in order for one of ordinary skill in the art to be motivated to combine the tapered tooth shape with the double square tooth shape disclosed by Black et al., one of ordinary skill in the art would need to master the subject matter in the following areas: (1) understand exclusion seal design principles; (2) understand vacuum/high pressure seal design principles; (3) know magnetic circuit theory; (4) know how to generate a strong magnetic field; (5) know how to create and relieve a magnetic choking situation; (6) know hot to use a sophisticated analysis tool; (7) know magnetic

leakage and its effect on pressure capacity; (8) know and understand magnetic focusing; and (9) know the effect of mechanical design on magnetic phenomena.

It is clear that one of ordinary skill in the art does not possess the knowledge and training necessary to glean from Black et al. in view of EP '656 the suggestion or motivation required to make Applicant's invention.

In light of the above arguments, Applicant respectfully submits that the 35 U.S.C. §103(a) rejections of Claims 1-19 have successfully been traversed. Allowance of these claims is therefore requested.

CONCLUSION

Applicant respectfully submits that the arguments presented herein successfully traverse the 35 U.S.C. §103(a) rejection of Claims 1-19 as being unpatentable over Black et al. in view of European Patent 182,656 A2. Allowance of Claims 1-19 is therefore requested.

Applicant believes that all of the pending claims should now be in condition for allowance. Early and favorable action is respectfully requested.

The Examiner is invited to telephone the undersigned, Applicant's attorney of record, to facilitate advancement of the present application.

Respectfully submitted,

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Robert R. Deleault, Reg. No. 39,165
Attorney for Applicant
41 Brook Street
Manchester, NH 03104
Tel. (603) 668-1971
Fax (603) 622-1445

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Robert R Deleault